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ABSTRACT

This study examined the relationship between the timing of feedback in programmed instruction and the cognitive levels of the tasks involved. The subjects were 195 college students from the Principles of Accounting I course at the University of Texas at Austin. Three test groups--an immediate feedback treatment group, an end-of-session feedback treatment group, and a next-session feedback treatment group--and one control group were given a pretest, and then completed the programmed instruction. The tasks for each session were divided into three cognitive levels: Level 1, or low cognitive level (defined concept); Level 2, or medium cognitive level (rules); and Level 3, or high cognitive level (problem-solving). It was found that on the low cognitive level tasks, subjects in the immediate feedback group did not score significantly higher on the delayed posttest than subjects in the next-session feedback group. In addition, on the high cognitive level tasks, subjects in the next-session feedback group did not score significantly higher on the delayed posttest than subjects in the immediate feedback group, after equating the two groups on knowledge from the prior tasks. Thus, it was concluded that there is an apparent ceiling effect on the delayed posttest, as evidenced by the high mean scores. The text is supplemented by six figures and four tables. (27 references) (EW)

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DELAY OF FEEDBACK AND COGNITIVE TASK LEVEL IN PRACTICE EXERCISES

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Running Head: Feedback in Practice

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DELAY OF FEEDBACK AND COGNITIVE TASK LEVEL IN PRACTICE EXERCISES

Feedback is a key element in a sequence of instruction. It is the means by which a learner is able to judge his or her performance. Without feedback, a learner is left to perform with no sense of direction or measure of correctness.

Weiner first identified feedback in his book Cybernetics (1948). He envisioned systems that were goal-seeking, taking small steps toward a predetermined goal. Feedback was the information which returned to the system after each step so that the system could adjust performance on the next step in order to reach the specified goal. Thus, feedback served to determine the direction in which the next step was taken.

Feedback as a formal component of instruction became prevalent in the 1960's with the widespread use of programmed instruction. Learning theorists called for feedback as an integral part of the instructional process while instructional designers included feedback as a formal step in the instructional process.

Feedback has been studied widely since the 1960's. Researchers have found varying degrees of importance of feedback, as well as conflicting ideas in the ideal application of feedback for instructional purposes. At least some of the differences in opinion in feedback research can be attributed to the many dimensions of feedback and the difficulty that exists in trying to control all of these dimensions. This paper is concerned with the dimension of timing of feedback.

Timing of feedback refers to the amount of time that elapses between the student's response and the presentation of feedback. This interval may be immediate or it may be delayed 5 seconds, 5 minutes, an hour, or a day.

The Behaviorists' view of feedback (Robin, 1978; Skinner, 1968; Weiner, 1948) was that it served as a reinforcer. This point of view required that feedback be provided immediately after the desired behavior in order to reinforce the behavior and increase the likelihood that it would be repeated.

Brackbill and her associates (1962), in experiements with third grade boys, found that delaying the presentation of feedback for as little as 5 seconds contributed to the increase of scores on retention tests given 8 days after the initial learning. This increase in retention after a delay in feedback has been named the Delay-Retention Effect (DRE).

The explanation offered by Brackbill and her associates for the Delay-Retention Effect was that the delay of feedback provided greater resistance to forgetting. Sturges and Crawford (1964) proposed that the DRE could be explained by the fact that those receiving delayed feedback spent the delay interval rehearsing the questions. This verbal rehearsal theory was also proposed by Sturges (1969) and Sassenrath and Yonge (1968, 1969). However, no one was able to support this verbal rehearsal theory with research results.

Kulhavy and Anderson (1972) proposed the Interference Perseveration Theory (IPT) as the reason for the DRE. The IPT stated that

> ...learners forget their incorrect responses over the delay interval, and thus there is less interference with learning the correct answers from the feedback. The subjects who receive immediate feedback, on the other hand, suffer from proactive interference because of the incorrect responses to which they have committed themselves. (p.506).

While this explanation applies to answers that are initially incorrect, it does not apply to initially correct answers. "The delay is not an issue in the case of a positive feedback since there is no competing response." (Joseph and Maguire, 1982, p. 360)

The Interference Perseveration Theory has been supported by several researchers (Bardwell, 1982; Sassenrath, 1972, 1975; Sturges, 1978; Surber and Anderson, 1975). While others (Peeck, Van Der Bosch, and Kreupleling, 1985; Sassenrath & Yonge, 1968; Sturges, 1978; Tabachneck, 1982) have challenged the IPT, there have been no rival theories presented and supported.

The timing of feedback has been investigated extensively over the past twenty-five years, with most of the research completed in the mid-1970's. There has been a resurgence of feedback research, however, in the 1980's which reflects the interest in the effective design of computer-assisted courseware. Research on retention and the timing of feedback typically uses a paradigm that involves a pretest or initial exposure to the items, a delay interval before the feedback, an immediate posttest after the feedback, and a delayed posttest after another delay interval. (See Figure 1) The immediate posttest provides a measure of initial acquisition while the delayed posttest provides a measure of the retention of learning.

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Insert Figure 1 here
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One variable that has contributed to the research on delay of feedback is that of the cognitive level of the tasks on which feedback is provided. Many researchers have suggested that delayed feedback is better for the higher cognitive levels (Anderson, Kulhavy and Andre, 1971; Bardwell, 1982; Brackbill, 1964; Gaynor, 1981; Kulhavy and Anderson, 1972; Markowitz and Renner, 1966; Sturges, 1978), but few studies have been conducted to determine the relationship of timing of feedback and cognitive level of the task. Of those studies which have dealt with this topic (Gaynor, 1973, 1981; Pound, 1977; Quiring, 1971; Tabachneck, 1982), none have found a significant relationship between the timing of feedback and the cognitive level of the task.

This paper reports the findings of a study on the relationship of timing of feedback and three cognitive levels of the tasks completed. The tasks for this study were classified according to the cognitive levels used in Gagne's hierarchy of learning (1985). This hierarchy was chosen, as opposed to those proposed by other educators such as Bloom (1956), because 1) it is widely accepted in the field of instructional design, 2) it is based on the postulate that the mental processing required for each type of learning and retention is different, 3) there is a body of research that also uses this hierarchy, and 4) prior studies with accounting have classified the accounting tasks with this hierarchy.

This study differed from prior studies on the relationship of the timing of feedback and cognitive levels in that the tasks were of a hierarchial nature; that is, task 2 built on the knowledge gained in task 1. In addition, the study was conducted in multiple sessions over a five week period while most delay-of-feedback studies have used a single session for presentation of the learning. Finally, this study differed from prior studies in that the treatments and dependent measures were all administered on the computer.

The hypotheses for this study were:

H1 On the low cognitive level task, subjects in the immediate feedback group will score significantly higher on the delayed posttest than subjects in the next-session feedback group.

H2 On the high cognitive level task, subjects in the next-session feedback group will score significantly higher on the dealyed posttest than subjects in the immediate feedback group, after

equating the two groups on knowledge from the prior tasks.

METHODS

Subjects

Subjects were 195 students from the Principles of Accounting I course at the University of Texas at Austin in the Fall of 1987. Four sections, taught by two assistant instructors, were designated by the supervising professor. One section was assigned as the control group. Students from the other three sections were randomly assigned to the three treatment groups as they entered the computer lab for the first time. Students who participated were given additional credit toward their final grade in the course.

Accounting was chosen as the topic for these exercises because there are a lot of concepts, rules, and problem-solving tasks that must be completed early in the Principles of Accounting course. This knowledge must be learned within the first four to five weeks of the semester. Without this basic knowledge, students are unable to understand the course content that follows and how it relates to their future careers.

Design

The study used a quasi-experimental design with subjects in four groups:

- control--an intact section taking only the written pretest and a written delayed posttest
- immediate feedback treatment group--took the written pretest, then completed 13 sessions on the computer, with feedback immediately after each incorrect answer
- end-of-session (EoS) feedback treatment group--took the written pretest, then completed 13 sessions on the computer, with feedback on incorrect answers given at the end of each computer session
- next-session feedback treatment group--took the written pretest, then completed 14 sessions on the computer, with feedback on incorrect answers given at the beginning of the next session following the session in which the exercise was completed

The tasks involved in the treatment sessions were classified into three cognitive levels:

Level 1 (low cognitive level): Defined Concept
The task was classifying accounts

Level 2 (medium cognitive level): Rules
The task was specifying debit or credit for an increase or decrease to accounts

Level 3 (high cognitive level): Problem-solving
The task was choosing the correct adjusting entry, given a particular situation

Instruments

Four parallel tests for each of the three cognitive levels were developed. The written pretest was given on the second day of class to subjects in both the control and the treatment groups and contained questions on all three cognitive levels. A background questionnaire was completed on the same day.

The embedded pretest, the immediate posttest and the delayed posttest were given to the subjects in the three treatment groups as a part of their computer sessions. The delayed posttest was given to the control group as a written in-class activity, at approximately the same time in the semester as most of the treatment subjects took it.

A week after the study ended a followup questionnaire was completed by subjects in the three treatment groups.

Materials

The computer program used to provide the practice exercises was a researcher-designed program, based on a linear design. The design features of the program included instructions on each new task, a review of the in-class learning for the new task, single keystroke responses, feedback on incorrect answers only, and the requirement to hit the space bar before proceeding after feedback had been presented. The program was written in PC Pilot and operates on an IBM PC computer with monochrome monitor and 256K of memory. No other materials were necessary.

Each session contained a specified number of items for each cognitive level. (See Table 1) The items for each session were drawn from the item pool, with no item repeated in the same session, and with each item repeated three times in the course of the study. For the immediate and end-of-session treatment groups, 13 sessions were required to complete the exercises; for the next-session group, 14

sessions were required. (Table 2)

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Insert Tables 1 and 2 here
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Subjects were asked to complete no more than one session per day, with an average of three sessions per week in order to coordinate the exercises with their in-class learning.

Different screen designs were used for each of the three cognitive levels and their associated tasks. Figures 1, 2, and 3 show the three screen designs.

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Insert Figures 2,3,and 4 here
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As a subject pressed the key for his/her choice, the key was highlighted on the screen. Feedback was given only on incorrect answers. This feedback consisted of an arrow pointing to the correct answer. When feedback was given, subjects in the immediate feedback treatment group could still see the highlighted key which indicated their answer choice. End-of-session and next-session treatment groups were not shown their original answer when they were given feedback.

No feedback was given on the posttests and the items presented on the posttests were not counted as item repetitions.

Procedure

On the second day of class for the semester all groups were given the written pretest and the background questionnaire. Subjects in the three sections which were not the control group were told that several software designs were being tested and were asked to report to the computer lab within the next few days to begin their computer sessions.

As they entered the computer lab they took a disk from the front of the storage box, wrote their identifying number on it, and began work at the computer. Each disk was preprogrammed and contained the sessions appropriate to the treatment group. Thus, students were randomly assigned to a treatment group as they took their disk.

Students completed one session at a time, with no

more than one session per day. At the end of each session their performance information was written to the disk and they refiled the disk. At their next session they took their disk and completed their work. Thus, subjects completed their work at their own pace. All sessions could be completed as early as the thirteenth day or as late as the end of the fifth week, which was the time limit for the study. Students were given a suggested time line and asked to stay as close to it as possible in order to maximize the effect of the computer-assisted exercises.

A week after the deadline for completion of the computer exercises, a questionnaire on the program design and student attitudes about it was completed by subjects who had done the exercises.

RESULTS

In order to determine if the groups were equivalent a One-Way Analysis of Variance was completed on the pretest scores for each of the three cognitive levels. These three ANOVAs indicated that there was no difference between the three treatment groups and the control group, nor among the three treatment groups. An additional Analysis of Variance was completed with the SAT scores for subjects in the four groups and it confirmed that there was no difference in the academic ability, as measured by the SAT, of the four groups.

In order to determine that the treatment was effective, a One-Way Analysis of Variance was completed on the delayed posttests for each cognitive level. On Level 1 and Level 2, all three treatment groups performed significantly better (at the .001 level) than did the control group. On Level 3, the immediate and end-of-session treatment groups performed significantly better than the control group, but the difference did not reach the .05 level of significance for the next-session treatment group.

Since the groups were shown to be equivalent and the treatment was effective, the control group was not included in the subsequent analyses.

In order to determine whether to reject the first null hypothesis, correlated t-tests were completed on the Written Pretest and the Delayed Posttest for Level 1. There was no significant difference in the F value for the immediate feedback treatment and the next-session feedback treatment on the low cognitive level. Therefore, the first null hypothesis was not rejected.

For the second null hypothesis, the hierarchial nature of the task had to be considered. Since the treatment might have provided an advantage to increase learning at the

lower cognitive levels, thus affecting the learning at the higher cognitive levels, a correction factor for prior learning had to be employed. Thus, the embedded pretest was used for the correlated t-test with the delayed posttest, since the embedded pretest represented the level of knowledge of problem-solving that the subject had when beginning the problem-solving activity. The results of the correlated t-tests were not significant. Further, an Analysis of Variance of the Adjusted Gain Score (delayed posttest minus embedded pretest) yielded no significant difference between the treatments on the high cognitive level task and the second null hypothesis was not rejected.

Further analysis of the treatment was completed with high and low ability subjects. The high and low ability groups were based on those subjects with SAT scores .25 of a standard deviation above or below the mean. Analyses of Variance were completed on each group, but failed to yield any significant difference in the treatments.

An Analyis of Variance with low and high prior-knowledge groups, as shown by the total pretest scores, was also completed. Using the top and bottom quartiles of the pretest scores, ANOVAs were completed on the delayed posttest for each cognitive level. There was a significant difference for the three treatment groups on the low and the high cognitive level tasks. Table 3 indicates that the group by pretest interaction on the Low Cognitive Level was significant at the .05 level, while Table 4 indicates that the group by pretest interaction on the High Cognitive Level was significant at the .01 level.

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Insert Tables 3 and 4 here
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Figure 5 shows that on the Low Cognitive Level task, the next session feedback was more effective for the low prior-knowledge group than for the high prior-knowledge group. Figure 6 indicates that there was a significant advantage to high prior-knowledge subjects when using the end-of-session feedback for the High Cognitive Level task, while low prior-knowledge subjects suffered in using this treatment. In contrast, low prior-knowledge students performed better when using the next-session feedback while high prior-knowledge students did not perform as well.

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Insert Figures 5 and 6 here
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CONCLUSIONS AND RECOMMENDATIONS

The lack of significant results in this study might be attributed to several factors:

First, there was an apparent ceiling effect on the delayed posttest, as evidenced by the high mean scores. This ceiling effect was not evident on the pilot study of the materials completed; however, none of the pilot subjects were coenrolled in the Principles of Accounting course.

Second, the amount of knowledge gained through co-enrollment in the accounting course and its required readings and homework might have offset the effect of the treatment. In comparison to the course knowledge, the amount of knowledge transmitted via the exercises was very small. While this knowledge did contribute to superior performance on the posttest, when compared to the control group, much of this might be attributed to the additional time on task and the additional practice on items that appeared on the posttest.

Future research should include a replication of this study with students not co-enrolled in the accounting course. Instructional materials could be prepared which served to introduce the topics drilled on the computer exercises within this study.

Another recommendation would be the further refinement of these materials to include questions of a more difficult nature so as to alleviate the ceiling effect.

A recommendation for the improvement of accounting education would be to include computer-assisted drills during the study of the first four to five chapters. This recommendation is warranted by the high correlation of the scores on the delayed posttests of the treatment groups with the scores on the first course exam ($p = .002$). In addition, an ANOVA of the first exam scores between those who completed the treatments and those in the control group approached the level of significance. With the relatively small investment of time (mean time on the treatments was 144 minutes), there is a significant increase in course achievement. Of course, additional research should be completed in the area of computer-assisted accounting drills.

Finally, more research is needed in the area of the relationship of the timing of feedback and the cognitive task level in order to determine whether or not a relationship exists and if so, what that relationship is.

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T1 _ _ _ _ _ _ _ _ _ _ _ _ F T2 _ _ _ _ _ _ _ _ _ _ _ _ T3
d1 r1

T1 = initial exposure to the item
d1 = delay interval before feedback
F = feedback
T2 = immediate posttest
r1 = retention interval before delayed posttest
T3 = delayed posttest

Figure 1

Paradigm for Delay-Retention Effect Research Studies

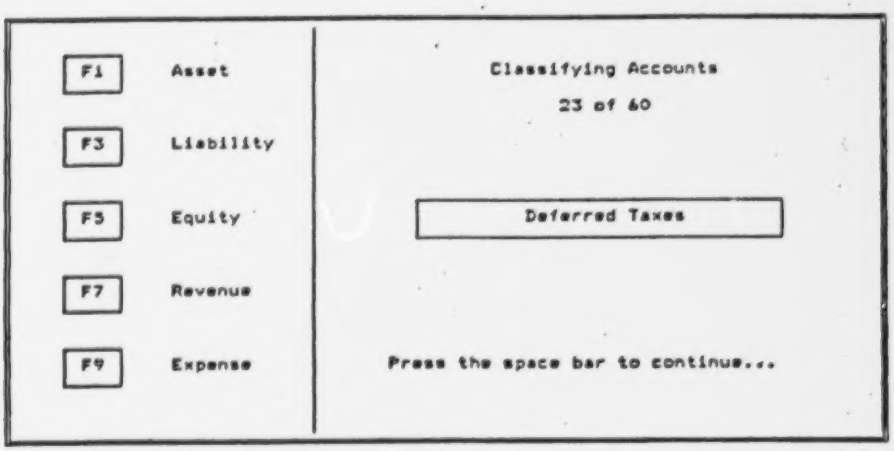

Figure 2

Screen Design for Low Cognitive Level Task (Classifying Accounts)

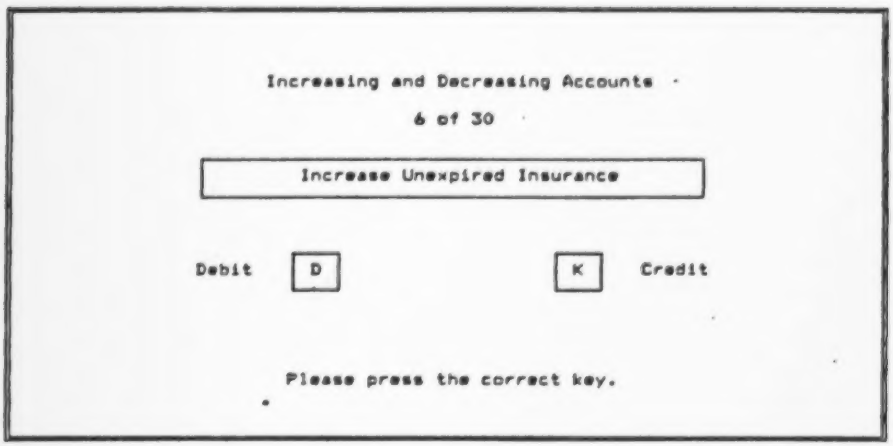

Figure 3

Screen Design for Medium Cognitive Level Task (Increasing/ Decreasing Accounts)

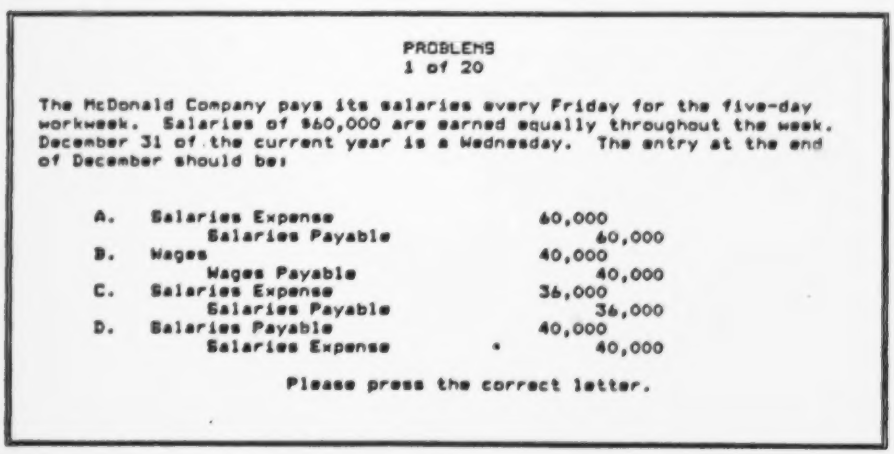
PROBLEMS
1 of 20
The McDonald Company pays its salaries every Friday for the five-day workweek. Salaries of $60,000 are earned equally throughout the week. December 31 of the current year is a Wednesday. The entry at the end of December should be:
A. Salaries Expense 60,000
Salaries Payable 60,000
B. Wages 40,000
Wages Payable 40,000
C. Salaries Expense 36,000
Salaries Payable 36,000
D. Salaries Payable 40,000
Salaries Expense 40,000
Please press the correct letter.

Figure 4

Screen Design for High Cognitive Level Task (Problem Solving)

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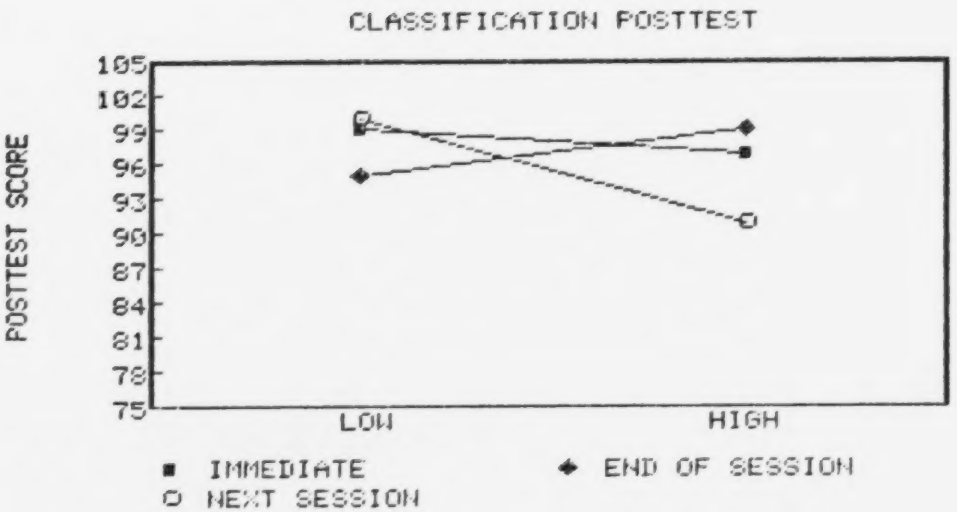

Figure 5

Low Cognitive Level Delayed Posttest Scores by Treatment Group for Low and High Quartiles on Written Pretest

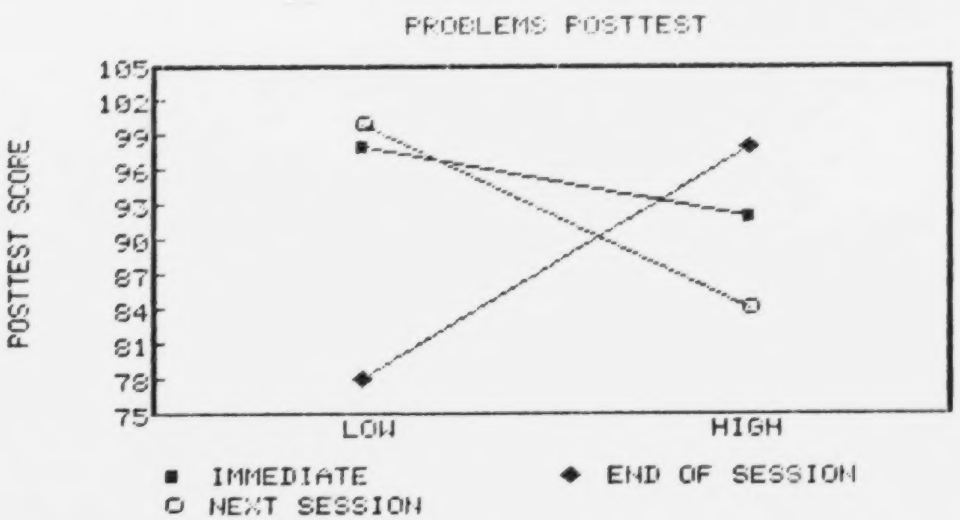

Figure 6

High Cognitive Level Delayed Posttest Scores by Treatment Group for Low and High Quartiles on Written Pretest

Table 1

Paradigm Summary for Immediate and EOS Treatment Groups

Session	Level 1 Classify	Level 2 IncDec	Level 3 Problems	Daily Total
1	60			60
2	30			30
3	20	60		80
4	20	80		100
5	20	70		90
6	20	50	10	80
7	10 & ipt	40	20	70
8		30	20	50
9		30 & ipt	10	40
10	dpt		10	10
11			10	10
12		dpt	10 & ipt	10
13			(a) dpt	
Total	180	360	90	630

	Item Repetitions to Total Items in the Pool		Number of Sessions
Classify	180:60	3.0	7
IncDec	360:120	3.0	7
Problems	90:30	3.0	7

ipt = immediate posttest
dpt = delayed posttest

(a) This session will be one week after the prior session.

Table 2

Paradigm Summary for Next Session Delayed Treatment Group (a)

Session	Level 1 Classify	Level 2 IncDec	Level 3 Problems	Daily Total
1	60			60
2	30			30
3	20	60		80
4	20	80		100
5	20	70		90
6	20	50	10	80
7	10	40	20	70
8	ipt	30	20	50
9		30	10	40
10		ipt	10	10
11	dpt		10	10
12			10	10
13		dpt	ipt	
14 (b)			dpt	
Total	180	360	90	630

	Item Repetitions to Total Items in the Pool		Number of Sessions
Classify	180:60	3.0	7
IncDec	360:120	3.0	7
Problems	90:30	3.0	7

ipt = immediate posttest
dpt = delayed posttest

(a) This paradigm is one session longer than that of the other treatment groups since the next session delayed group must come in for feedback one day after they complete the exercises. Thus, their immediate posttest on the problems is given one day later than the other groups.

(b) This session will be one week after the prior session.

Table 3

ANOVA of Treatment Group by Low and High Quartiles on Written Pretest Scores for Low Cognitive Level Task

Source	df	Mean Square	F	p
Main Effects	3	47.65	.839	.479
Group	2	34.72	.612	.547
Posttest	1	72.59	1.279	.264
Interactions				
Grp X Posttest	2	181.76	3.202	.050*
Explained	5	101.30	1.784	.134
Residual	48	56.77		
Total	53	60.97		

* $p < .05$

Table 4

ANOVA of Treatment Group by Low and High Quartiles on Written Pretest Scores for High Cognitive Level Task

Source	df	Mean Square	F	p
Main Effects	3	184.69	1.331	.275
Group	2	277.02	1.997	.147
Posttest	1	5.93	0.043	.837
Interactions				
Grp X Posttest	2	1478.15	10.653	.001**
Explained	5	702.07	5.060	.001
Residual	48	138.75		
Total	53	191.89		

** $p < .01$